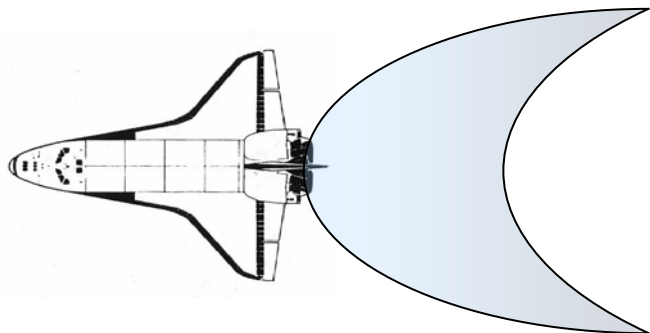




INFRARED SPECTRAL MEASUREMENTS OF SHUTTLE ENGINE FIRINGS

AMOS 2005 TECHNICAL CONFERENCE WORKSHOP

**5 September, 2005
Maui, Hawaii**



**M. Venner
AFRL, Edwards AFB, CA**

**M. Braunstein, L. Bernstein
Spectral Sciences, Inc., Burlington, MA**

**R. Dressler
AFRL, Hanscom AFB, MA**

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Space Shuttle Exhaust Plume Infrared Measurement Analysis

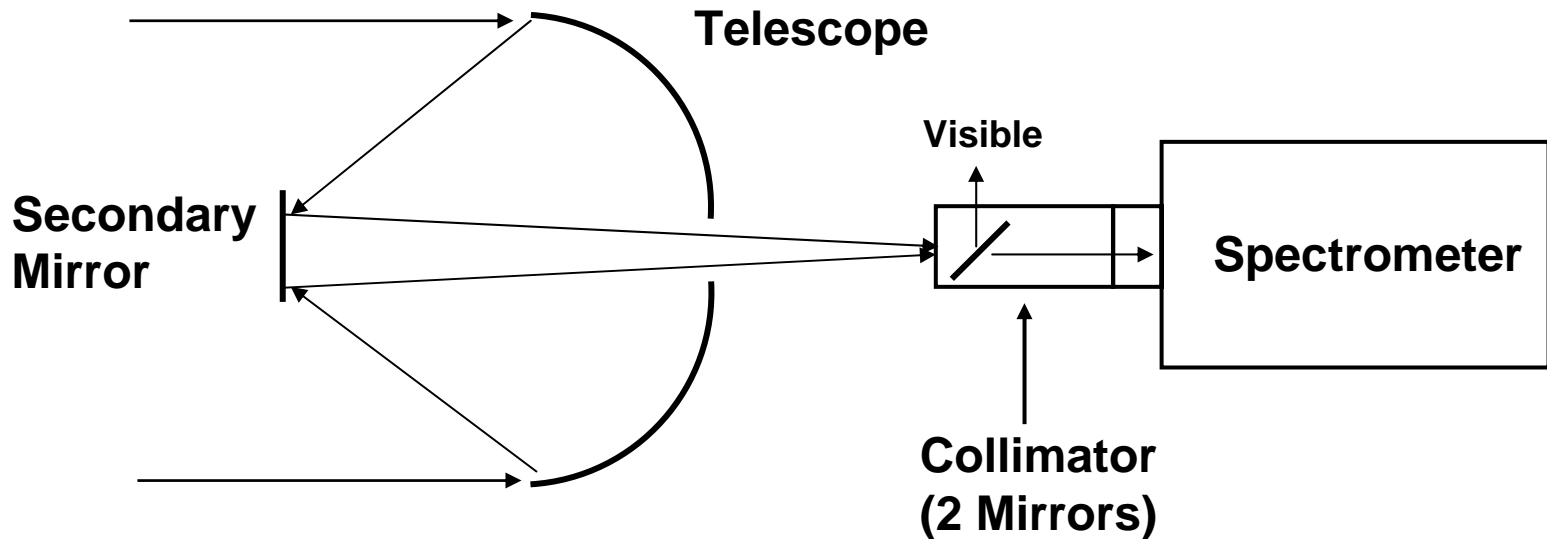
- **Utilize Total Signal Calculation to Estimate a Signal-to-Noise for Two Available Spectrometers – 3.76×10^4 W (11 km/s Case)**
- **Assume Both Integrable onto AMOS Telescope (Most Likely B37)**
- **5 km Diameter Plume at 390 km Altitude and 60 Degree View From Zenith**
- **Expect Plume Radiance to Fill the FOV (B37 is Only 3 mrad Total)**
- **Calculate Average Radiance by Dividing by 4π Steradians and Estimated Plume Area**

ABB (Bomem) FTIR Spectrometer Spec's

- **Two Simultaneous Non-Imaging Detectors**
 - 1- 6 μm InSb, 1.37e-09 RMS NESR at 1 cm^{-1} Resolution
 - 2 - 15 μm MCT, 1.4e-08 NESR at 1 cm^{-1}
 - Currently Use LN2 for Detector Cooling
- **5, 28, 75 mrad Telescopes Available as Attachments**
- **LN2 Cooled Cold Source**
- **Weight – 45 kg Nominal**
- **Scan Rate and Spectral Resolution Specifications:**

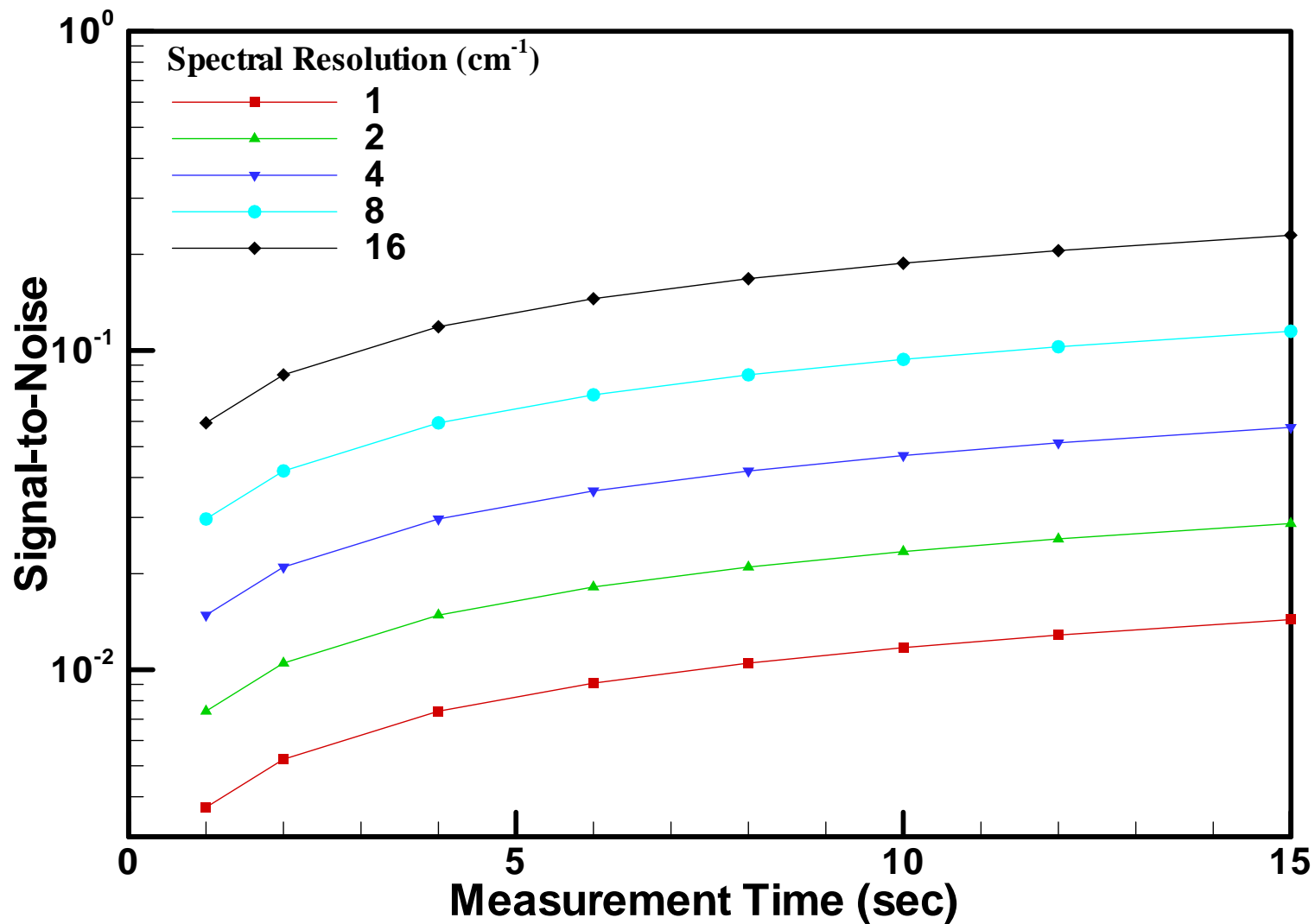
Resolution (cm^{-1})	16	8	4	2	1
Frame Rate (scans/sec)	64.6	47.8	31.4	18.6	10.3
Maximum Acq Time (sec)	242	163	125	104	95

Current Measurement Method



- **Collimator Input Aperture – 6.4 mm (Field Stop)**
- **45 mrad FOV**
- **Must Form Image at Collimator Entrance**
- **Can Use Visible Light to Characterize FOV**

ABB FTIR InSb Detector S/N Calculations



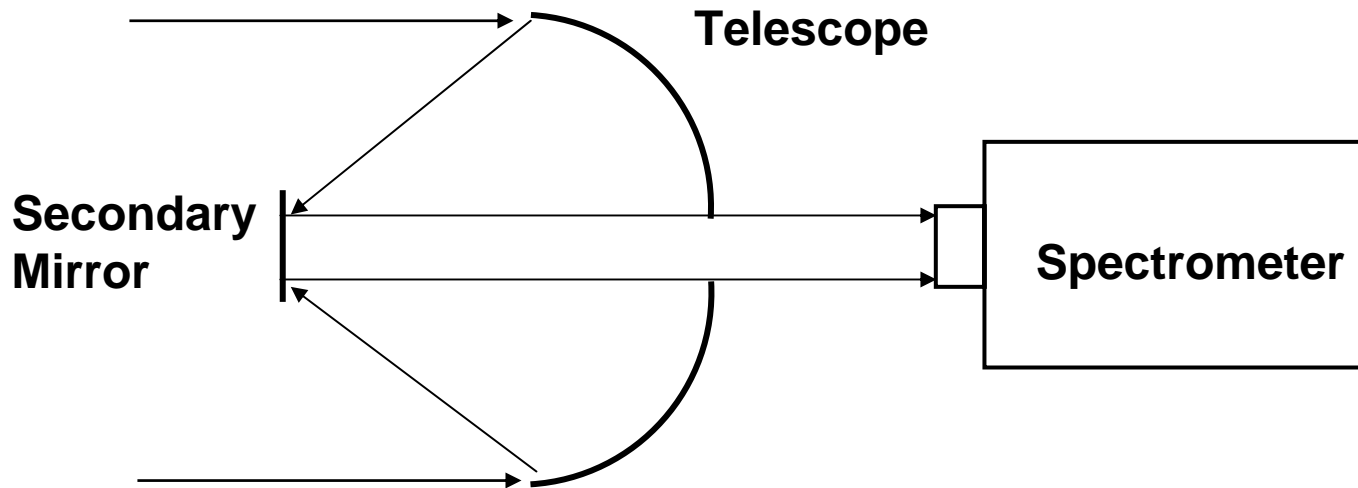
Broadband Array Spectrograph System (BASS)

- **Aerospace Corporation Sensor (Dave Lynch)**
- **Wavelength Dispersive System – 2 Prisms**
- **116 Total Detectors**
- **3 – 13.5 μm Waveband**
- **Approximately 0.1 μm Resolution (Much Lower Than Desired)**
- **Noise Equivalent Power: 4.0e-14 W/Sqrt(Hz) (1 Sec Integration)**
- **Frame Rate: 0.1 – 200 Hz**
- **Estimate S/N = 1448 Over the 3 – 4.2 μm Region**
 - **Calculations Not Reviewed by Aerospace Corp. Personnel**

Potential Solutions/Improvements

- **Large Telescope With a Short Focal Length (i.e. Fast Optics)**
- **OHMS Burn at 250 km Altitude – De-Orbit?**
- **Simultaneous Firing of Two PRCS Engines**
- **Install More Sensitive Detectors – Significant Cost**
- **Upgrade to New 300 Series System – X2 Improved Sensitivity**
- **Estimate Additional Signal From Other Species - O + CO, O + H₂, etc.**
- **Afocal Telescope System**

Afocal Telescope System



- **Spectrometer Input Aperture – 1.5 in. (3.8 cm)**
- **Must Be Well Collimated Beam**
- **May Allow a Larger FOV**
- **Reduce Reflection Loss Due to Two Less Mirror Reflections**
- **No Dichroic Mirror to Divert the Visible Light for FOV check**

Conclusions

- **ABB FTIR Spectrometer Not Sensitive Enough With Present Configuration**
- **BASS Sensor Appears to Have Sensitivity But Very Low Spectral Resolution**
- **Additional Analysis Required**